

HAND GESTURE INTERACTION WITH TOUCH SURFACE

FIELD OF THE INVENTION

[0001] This invention relates generally to touch sensitive surfaces, and more particularly to using touch surfaces to recognize and act upon hand gestures made by touching the surface.

BACKGROUND OF THE INVENTION

[0002] Recent advances in sensing technology have enabled increased expressiveness of freehand touch input, see Ringel et al., "Barehands: Implement-free interaction with a wall-mounted display," Proc CHI 2001, pp. 367-368, 2001, and Rekimoto "SmartSkin: an infrastructure for free-hand manipulation on interactive surfaces," Proc CHI 2002, pp. 113-120, 2002.

[0003] A large touch sensitive surface presents some new issues that are not present with traditional touch sensitive devices. Any touch system is limited by its sensing resolution. For a large surface, the resolution can be considerably lower than that with traditional touch devices. When each one of multiple users can simultaneously generate multiple touches, it becomes difficult to determine a context of the touches. This problem has been addressed, in part, for single inputs, such as for mouse-based and pen-based stroke gestures, see André et al., "Paper-less editing and proofreading of electronic documents," Proc. EuroTeX, 1999, Guimbretiere et al., "Fluid Interaction with high-resolution wall-size displays. Proc. UIST 2001, pp. 21-30, 2001, Hong et al., "SATIN: A toolkit for informal ink-based applications," Proc. UIST 2000, pp. 63-72, 2001, Long et al., "Implications for a gesture design tool," Proc. CHI 1999, pp. 40-47, 1999, and Moran et al., "Pen-based interaction techniques for organizing material on an electronic whiteboard," Proc. UIST 1997, pp. 45-54, 1992.

[0004] The problem becomes more complicated for hand gestures, which are inherently imprecise and inconsistent. A particular hand gesture for a particular user can vary over time. This is partially due to the many degrees of freedom in the hand. The number of individual hand poses is very large. Also, it is physically demanding to maintain the same hand pose over a long period of time.

[0005] Machine learning and tracking within vision-based systems have been used to disambiguate hand poses. However, most of those systems require discrete static hand poses or gestures, and fail to deal with highly dynamic hand gestures, Cutler et al., "Two-handed direct manipulation on the responsive workbench," Proc 13D 1997, pp. 107-114, 1997, Koike et al., "Integrating paper and digital information on EnhancedDesk," ACM Transactions on Computer-Human Interaction, 8 (4), pp. 307-322, 2001, Krueger et al., "VIDEOPLACE—An artificial reality, Proc CHI 1985, pp. 35-40, 1985, Oka et al., "Real-time tracking of multiple fingertips and gesture recognition for augmented desk interface systems," Proc FG 2002, pp. 429-434, 2002, Pavlovic et al., "Visual interpretation of hand gestures for human-computer interaction: A review," IEEE Transactions on Pattern Analysis and Machine Intelligence, 19 (7), pp. 677-695, 1997, and Ringel et al., "Barehands: Implement-free interaction with a wall-mounted display," Proc CHI 2001, pp. 367-368, 2001. Generally, camera-based systems

are difficult and expensive to implement, require extensive calibration, and are typically confined to controlled settings.

[0006] Another problem with an interactive touch surface that also displays images is occlusion. This problem has been addressed for single point touch screen interaction, Sears et al., "High precision touchscreens: design strategies and comparisons with a mouse," International Journal of Man-Machine Studies, 34 (4), pp. 593-613, 1991 and Albinsson et al., "High precision touch screen interaction," Proc CHI 2003, pp. 105-112, 2003. Pointers have been used to interact with wall-based display surfaces, Myers et al., "Interacting at a distance: Measuring the performance of laser pointers and other devices," Proc. CHI 2002, pp. 33-40, 2002.

[0007] It is desired to provide a gesture input system for a touch sensitive surface that can recognize multiple simultaneous touches by multiple users.

SUMMARY OF THE INVENTION

[0008] It is an object of the invention to recognize different hand gestures made by touching a touch sensitive surface.

[0009] It is desired to recognize gestures made by multiple simultaneous touches.

[0010] It is desired to recognize gestures made by multiple users touching a surface simultaneously.

[0011] A method according to the invention recognizes hand gestures. An intensity of a signal at touch sensitive pads of a touch sensitive surface is measured. The number of regions of contiguous pads touched simultaneously is determined from the intensities of the signals. An area of each region is determined. Then, a particular gesture is selected according to the number of regions touched and the area of each region.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. 1 is a block diagram of a touch surface for recognizing hand gestures according to the invention;

[0013] FIG. 2A is a block diagram of a gesture classification process according to the invention;

[0014] FIG. 2B is a flow diagram of a process for performing gesture modes;

[0015] FIG. 3 is a block diagram of a touch surface and a displayed bounding box;

[0016] FIG. 4 is a block diagram of a touch surface and a displayed bounding circle; and

[0017] FIGS. 5-9 are examples hand gestures recognized by the system according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0018] The invention uses a touch surface to detect hand gestures, and to perform computer operations according to the gestures. We prefer to use a touch surface that is capable of recognizing simultaneously multiple points of touch from multiple users, see Dietz et al., "DiamondTouch: A multi-user touch technology," Proc. User Interface Software and Technology (UIST) 2001, pp. 219-226, 2001, and U.S. Pat. No. 6,498,590 "Multi-user touch surface," issued to Dietz et